Target Based Rapid Prototyping Control System for Engine Research

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Abstract:
Today's advanced technology engines have a high content of electronic actuation requiring sophisticated real-time embedded software sensing and control. To enable research on such engines, a system with a flexible engine control unit (ECU) that can be rapidly configured and programmed is desired. Such a system is being used in the Advanced Internal Combustion Engine (AICE) Laboratories at Michigan Tech University (MTU) for research on a multi-cylinder, spark-ignited gasoline, a high-pressure, common-rail diesel and a single-cylinder alternative fuels research engine. The system combines a production ECU with a software development system utilizing Mathworks Simulink/Stateflow\sC modelling tools. The interface in the Simulink modelling environment includes a library of modelling and interface blocks to the production Operating System (OS), Low Level Drivers (LLD) and CAN-based calibration tool. The controls development and software compilation is completed entirely in the modelling environment with the models autocoded to C and linked and compiled with commercial-off-the-shelf software tools. With this Target-Based, Rapid-Prototyping system, software sets have been developed that employ time and angle-based preemptive multitasking components. The components developed and integrated include control of the primary actuators, fuel and spark, along with a comprehensive set of secondary actuation including high-pressure fuel pump, electronic throttle, variable cam phase, exhaust gas recirculation control and combustion knock detection and control. Tasking models generated for the gasoline and diesel engine applications are provided and discussed with respect to their integration into the architecture. In addition, the implementation of the variable cam timing phase detection for the gasoline application is discussed as an illustrative example of the tool, process and architecture.